

# **Pbar Note 624**

## **Accumulator 4-8 GHz**

### **Cooling Pickups Impedance**

### **Measurements**

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#### **ABSTRACT**

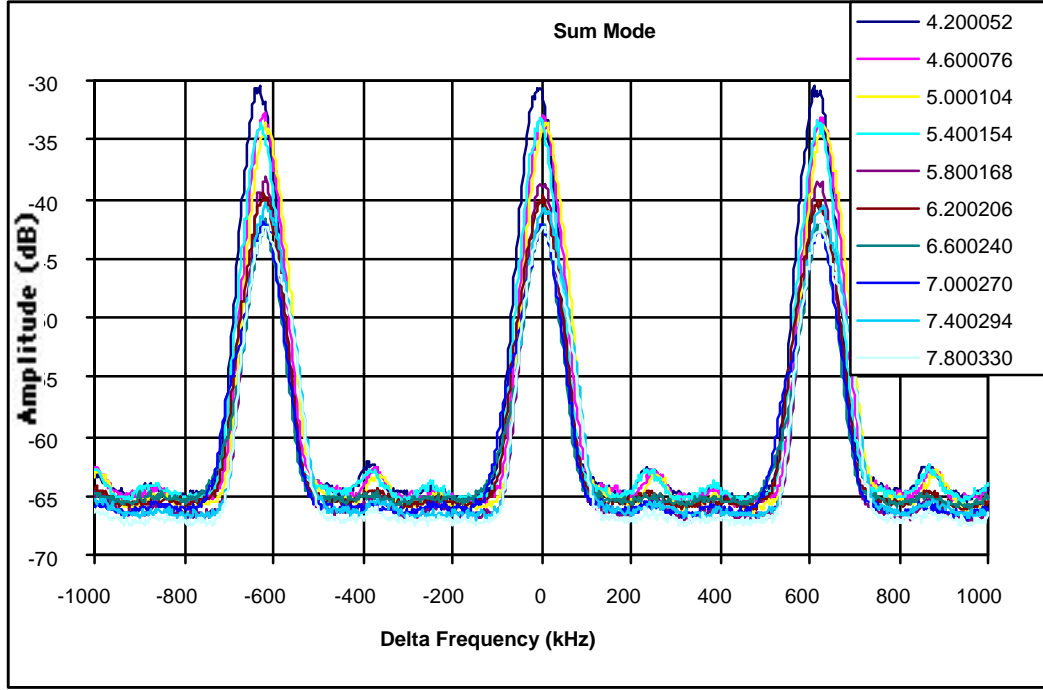
Impedance measurements for the Accumulator 4-8 GHz cooling pickups are presented for both sum and delta modes. At the low end of the band, the impedance is approximately  $4.7\ \Omega$  ( $2.3\ \Omega$ ) in sum (difference) mode, falling to approximately  $0.75\ \Omega$  ( $0.5\ \Omega$ ) in sum (difference) mode at the high end of the band.

#### **1. Spectrum Analyzer Measurements**

Narrow band measurements were made in both sum and delta mode. They spanned 2 MHz, with 1000 points apiece. For sum mode, we have measurements centered at 4.2, 4.6, 5.0, 5.4, 5.8, 6.2, 6.6, 7.0, 7.4, and 7.8 GHz. For delta mode, we have measurements at 4.2, 4.6, 5.0, 5.4, and 7.0 GHz. Pictured below in Figure 1 and Figure 2 are summary distributions for these measurements. They are all plotted on the same horizontal scale, subtracting out the central frequency. For these measurements, there was approximately 43 mA of beam in the Accumulator.

#### **2. Impedance Calculations**

Following the calculation of Pbar Note 580, we need to have measures of the total power (signal + noise) in a Schottky band and noise power in a Schottky band. For the total power, we integrate the power in a 628 kHz section of spectrum analyzer measurement. For the noise power, we take an average value of the power in the region between the beam distributions (e.g., between  $-250\ \text{kHz}$  in  $-150\ \text{kHz}$  as shown in Figure 1 for the sum mode) and multiply by the number of bins (in this case, 314). For the delta mode distributions, we cut out the region where the longitudinal signal leaks in and add in additional noise power for those bins.



**Figure 1: Sum Mode Amplitude Measurements**

We assume an amplifier noise figure of 1.6 dB, a beam emittance of  $4 \pi$  mm mr and value of  $\beta = 8$  m. We use the following expressions for the calculation of the impedance in the sum and delta modes:

$$Z_{\Sigma} = (g - 1) \frac{N_f S_{therm}}{e I_{DC}}, g = \frac{P_{Signal} + P_{Noise}}{P_{Noise}}$$

$$Z_{\Delta} = (g - 1) \frac{N_f S_{therm}}{2 e I_{DC} \left( \frac{s}{d} \right)^2}, s = \frac{eb}{6p}$$

and  $d$  is the beam aperture (3.3 cm). We calculate the impedance at each frequency point. In Figure 3 and Figure 4 are the sum and delta mode impedances for the pickup array. Since there are 32 loops in the pickup array, the individual loop impedance is smaller than what is displayed in the figures by a factor of 32. As the emittance is assumed for the delta mode measurements, they are not as reliable as the sum mode measurements.

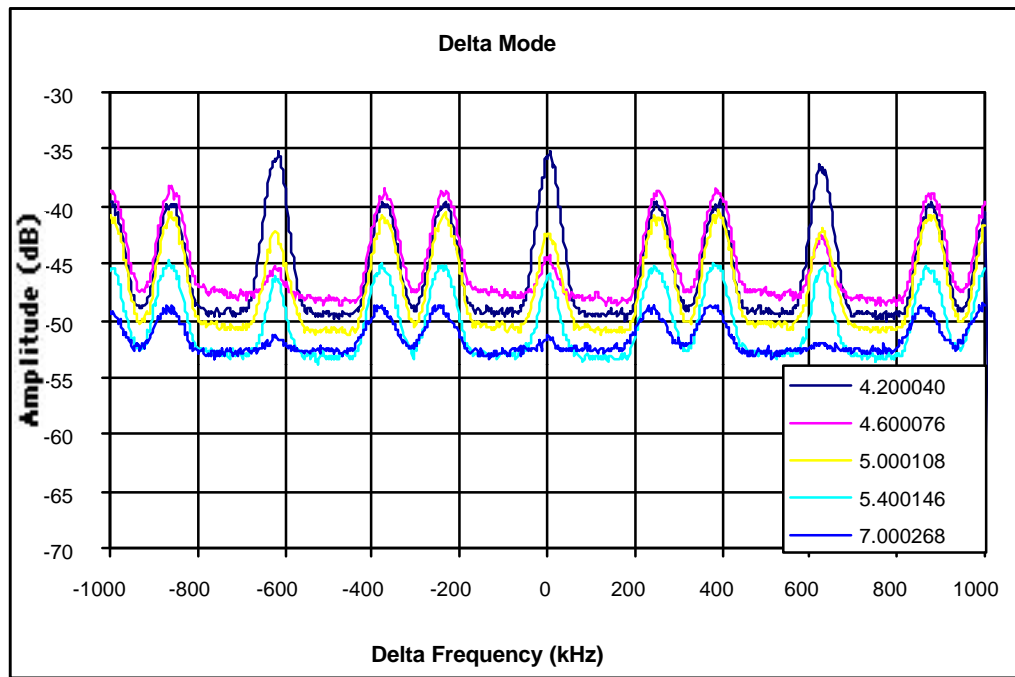


Figure 2: Delta Mode Amplitude Measurements

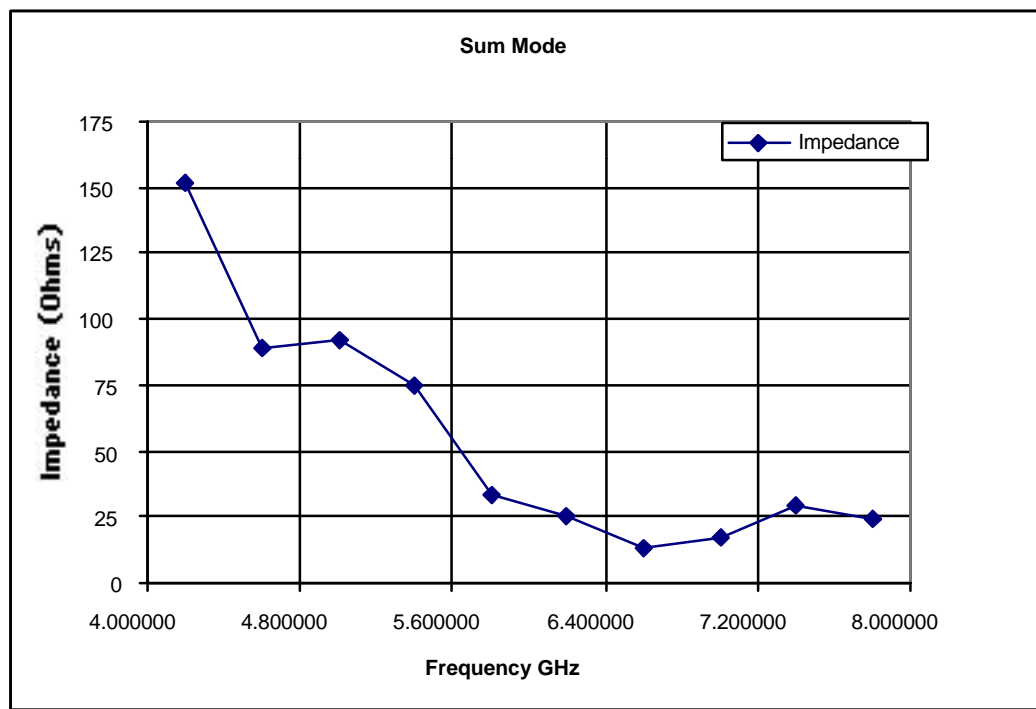
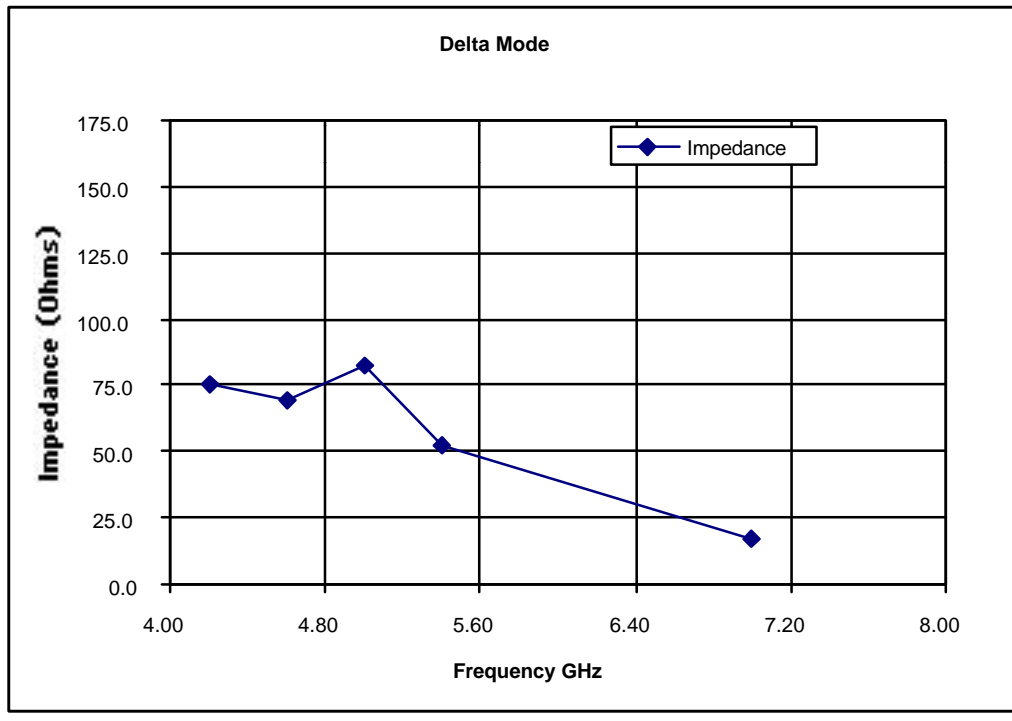


Figure 3: Sum Mode Impedance for the 32 loops



**Figure 4: Delta Mode Impedance for the 32 loops**

### **3. Conclusions**

With spectrum analyzer measurements ranging across the 4-8 GHz frequency band, impedance measurements have been done. The individual loop impedance is approximately  $4.7 \Omega$  ( $2.5 \Omega$ ) in the sum (delta) mode at 4.2 GHz, falling to  $0.75 \Omega$  ( $0.5 \Omega$ ) at 7 GHz. Another set of measurements with these pickups is planned for the summer of 99.